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HAWAII AGRICULTURAL EXPERIMENT STATION

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E. V. WILCOX, Special Agent in Charge.

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Corn Culture and Improvement.

By

C. K. McCLELLAND, Agronomist.

Corn is one of the principal forage and grain crops and the chief silage crop grown. It was not until America was discovered that this valuable plant became known and cultivated in other regions, and it is perhaps not to be wondered at that a crop which has such a wide adaptability to soils and climate, should find its largest acreages and best development upon the American continent where it originated. In both North and South America it is one of the main feeds depended upon by dairy men, general farmers, and stock men. In Hawaii it has been grown for years, and here it has a wide range of adaptability, being grown under various conditions of soils, moisture, elevation and seasons. Upon the higher lands as at Kula and Waikii, it is planted in the spring, while at lower elevations it may be grown at any time, but makes its best growth when assured of plenty of moisture or, upon leeward sides, as a winter crop. The following tables gives the percentage composition of corn, in various parts and conditions:

	DRY GRAIN			Fresh Silage	FIELD CURED		Corn & Cob Meal	WATER FREE		
	Dent.	Flint	Sweet		Fodder	Stover		Horny Portion	Floury Portion	Germ.
Water	10.6	11.3	8.8	79.1	42.2	40.1	15.1			
Ash	1.5	1.4	1.9	1.4	2.7	3.4	1.5			9.9
Protein	10.3	10.5	11.6	1.7	4.5	3.8	8.5	10.	7.	19.8
Crude Fiber	2.2	1.7	2.8	6.	14.3	19.7	6.6			
Nit. free Extract	70.4	70.1	66.8	11.1	34.7	31.9	64.8			
Fat	5.	5.	8.1	8.	1.6	1.1	3.5	1.	.8	34.8

Fodder is the name applied to the entire plant, while stover applies to stalk and leaves after removal of the ears and may or may not include the husks.

In structure the grain is made up of the embryo or germ; the endosperm, consisting of white and horny portions; and the outer covering composed of the *aleurone layer* and the outer hull, the latter being in turn composed of several parts as may be seen under the microscope. Upon one side of a kernel or grain of corn may be seen a depression extending from near the bottom or point of the kernel 1-3, 1-2, or even nearly to the top of the kernel. This shows the position and size of the embryo. When selecting for content of oil or protein, kernels with large embryos are taken.

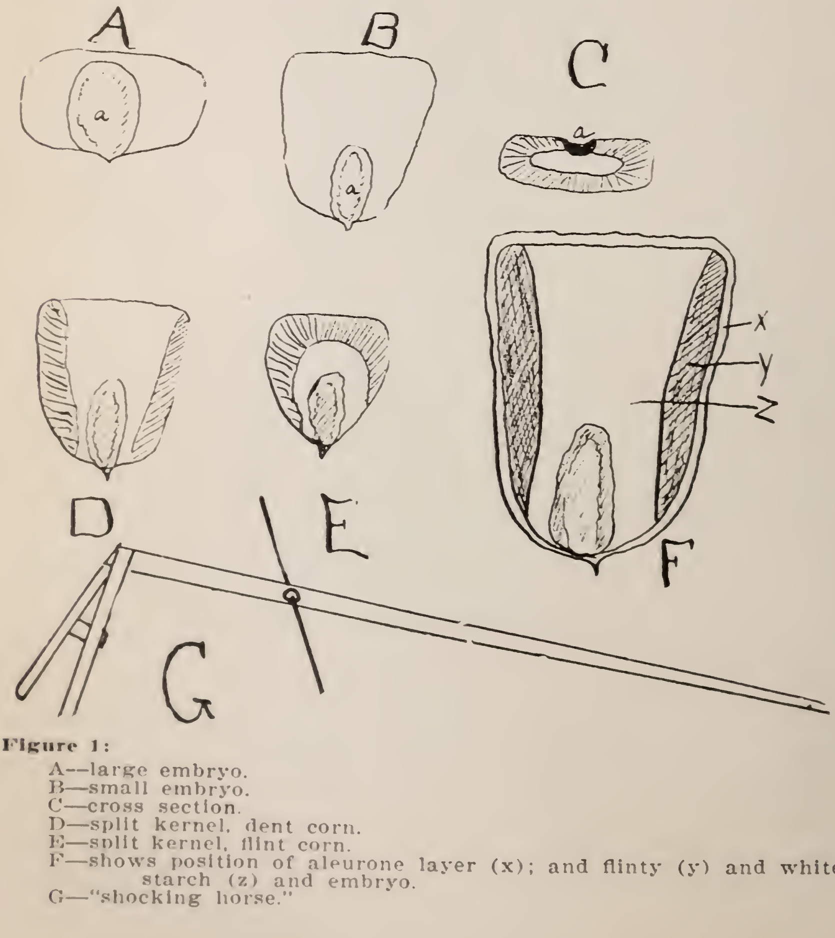

Figure 1:
A—large embryo.
B—small embryo.
C—cross section.
D—split kernel, dent corn.
E—split kernel, flint corn.
F—shows position of aleurone layer (x); and flinty (y) and white starch (z) and embryo.
G—"shocking horse."

Fig. 1—A, B and C show the position of the embryo in whole kernels and in cross section. If the grain be split through its two largest dimensions the floury and horny portions of the endosperm will be seen as in figure 1—D and E.

Selections to increase starch content must be made of kernels with a large proportion of the white or floury portion. To increase protein content select for large proportion of horny portion and also for large embryo, as implied in the table giving composition of various parts. The aleurone layer is a layer of cells occurring beneath the outer skin and may be seen by removing the latter (by soaking in hot water for about 15 minutes.) In blue, purple or black corn the color is in the aleurone layer. The red color of corn lies in the hull, while yellow and white colors are from the endosperm, or, to less extent, from the aleurone layer. As between the yellow and white varieties, which are the ones more commonly raised, there is evidence that white varieties yield the better but that there is no difference in composition or feeding value.

SPECIES.[1]

Corn is divided into six agricultural types or species, known as pod, pop, flint, dent, soft and sweet, corn—or maize as it is known beyond the boundaries of the United States.

In figure 1-D will be seen dent corn in which the white or floury portion of the endosperm extends to the top. At E, flint corn in which it does not.

In pop corn, nearly all of the endosperm is horny; in soft corn it is all white; in sweet corn, the endosperm is nearly all horny in appearance, the starch having been reduced to sugar; in pod corn each kernel has a separate husk in addition to that covering the ear.

VARIETIES.

The varieties of these species are innumerable. Variations occur in the height and circumference of the stalks, in the length and width of leaves, in the position at which the ear is borne, in the number of ears, in the length and circumference of the shank, in the length and circumference of the cob and ears, in the number of rows of kernels, in their size, shape, color, etc.

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[1] Bulletin No. 161, Bureau of Plant Industry, U. S. Department of Agriculture describes another type of corn from China which has a distinctly waxy endosperm.

There is also great variation in the time required for maturity and in vigor and productiveness of different varieties under different conditions.

There are many well established varieties of each type of corn, all of which do well under certain conditions. The choice of a variety of corn is of much less importance than the improvement of the variety when once chosen.

Farmer's Bulletin No. 414 of U. S. Department of Agriculture says that little importance can be attached to varietal names since the seedsmen keep so busy interchanging them (or renaming) and the wind continually mixes varieties by cross pollination.

Vigor, or in other words productiveness, uniformity and adaptability to soil and climate are the important things to consider. It was the writer's experience under semi-arid conditions of Western Kansas that varieties grown there for a score of years would out yield newly imported varieties. Probably it will be equally true that varieties grown for some time in Hawaii will be better adapted to our conditions than any that can be brought in. Importation however should continue, but only upon a small scale, in attempts to secure better results. Larger yields are likely to be secured by later maturing varieties under good conditions. However where the supply of water is liable to be cut off by drought, early maturing varieties may excel.

THE SEED.

According to Farmer's Bulletin No. 415 good seed is seed that is adapted to soil and seasonal conditions, that was grown on productive plants of a productive variety, and is well matured and has been preserved with full vigor.

When seed has been selected, unless already well dried, it should be dried as soon as possible and kept dry. In colder climates corn containing too high a per cent of moisture is injured or killed by freezing. In any climate, it pays to take good care of the seed. Various methods of storing seed are in use. Braiding the husks of several ears together and hanging them in shed, stable, kitchen, or attic, is a very common method. Tying several ears on a string and suspending from a rafter is also quite common. In large seed houses the corn is usually placed on shelves, an elaborate system of which provides storage for an immense amount of seed. Protection against rodents and insects should always be provided.

As stated under "yields," the yield may depend upon the stand and the stand of course depends upon good seed. The better farmers of today are testing their seed to insure a good stand.

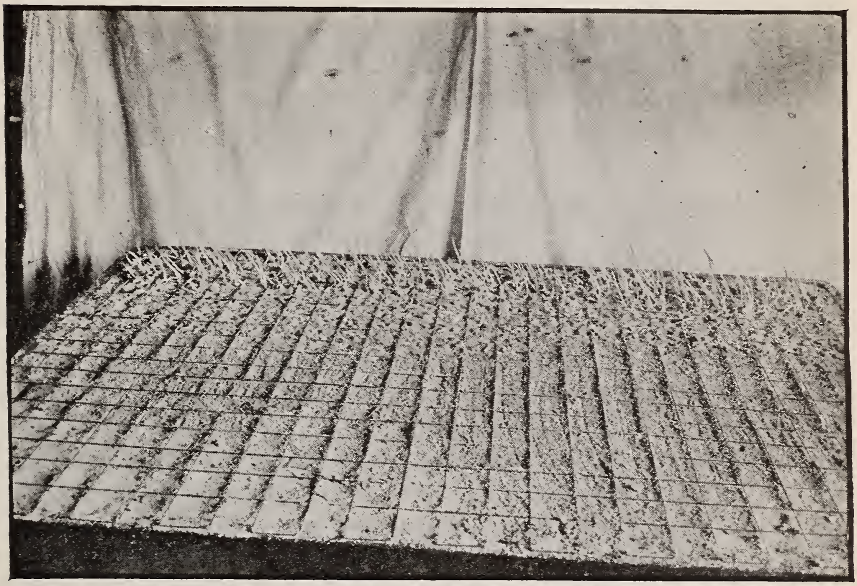

Figure 2: Seed Tester,—for testing individual ears of corn.

For shelled seed a good tester is made by using two ordinary plates and two sheets of blotting paper, or carpet paper. Place the seed upon one paper in a plate and cover with the second paper, put in sufficient water, and invert the second plate over this to prevent evaporation. Keep in a warm place. A more scientific method of testing is to test each ear. Take a shallow box 2′ to 3′ wide by 4′ or 5′ long and 2″ deep. Drive small brads or tacks into the edges at intervals of about 1½″ and with a string divide the box into 1½″ squares, as shown in figure 2 (first filling the box with sand.) With this, as many ears may be tested as there are squares. Place ears on shelves or tables in a long row, driving nails after each ten for convenience in locating the ears. Take from the ears, consecutively, three or four kernels from different parts and place, consecutively, in the tester and moisten and cover. With this simple contrivance any poor ears are detected and thrown out. All should come up at once; those coming first are generally supposed to be the better, but some experiments have given a slightly larger yield from those coming up last. After testing, the seed ears must be shelled, preferably by hand, but always discarding tip and butt kernels, which being odd in shape and size interfere with uniform work of the planter. Seed, from the tips especially, are thought to be less productive and are more likelv to be moldy and to have lost their vitality. In hand-shelling, any bad kernels, or ears having ill-shaped kernels may be more readily detected and discarded.

SOILS FOR CORN, AND PREPARATION.

Corn for its best development requires deep, fertile soil. The alluvial soils to be found in the river bottoms furnish ideal conditions for this crop. These would be described as silt loam soils containing more than the average amount of humus. Clay soils, when plenty of organic matter is turned under and mixed in, and when sufficiently well drained, will produce excellent corn. Sandy soils do not require the organic matter to ameliorate their physical condition like the clay soils; they need it to increase their fertility and moisture holding capacity.

Ordinarily deeper plowing is done for corn than for the other grains—the depth must be determined by conditions of soil and climate. Sometimes deep plowing would facilitate percolation and again, on thin soils, it would expose inert material. Whether to plow in fall or spring also is dependent on conditions of soils and climate, and upon the system of farming practiced. Listing, as explained under planting is a substitute for plowing. When double listing is practiced, the first listing is given in late summer or fall leaving the surface ridged and exposed until planting season, when the second listing destroys these ridges and creates others where the furrows were. On listed ground, if the furrows run nearly level, surface drainage is checked and water allowed to percolate; if the furrows run "up and down" surface drainage is aided and a loss of water results. With soils more or less granular in structure, as on the Great Plains, listing at right angles to the prevailing wind retards blowing. With floury soils, as in parts of Hawaii, less benefit would likely result.

The after preparation for corn depends largely upon the condition of soil after plowing. If the soil is exposed and left in large clods, these must be broken up by disc harrows. If the clods are small, a few days of exposure to sun and wind, followed by a harrowing with a spike-tooth harrow, will leave the ground in fair shape for planting. Except with the two horse planter which carries its own marker, or for grain drills, the field must be marked off for planting. By running a plank drag over the field or otherwise smoothing the surface, the track of a marker may be more easily seen. In the South many animals are trained so well that, with the one row planter, no previous marking is necessary, the animals keeping the required distance from each preceding row. For planting with the hand planters fields are usually checked with sleds having three or four runners spaced at proper distances for rows. Upon the return trip across the field each time, one runner follows the outer track of the previous trip so that all rows are at uniform intervals. For planting with hand hoes, the work is made easier if the field is marked with a small plow. The corn can then be dropped in the furrow and covered with the hoe, avoiding the necessity of digging a small opening for the seed or of planting right at the surface.

The season for planting, as stated, may vary. Corn requires higher temperature than do small grains, both for germination and growth, and makes its best growth in hot, humid sections. Cold nights tend to check its growth and hasten maturity. At higher elevations then it should not be planted until the nights become warmer.

PLANTING CORN.

The operation of planting may be performed by man and hoe first lining off the field in one or both ways accordingly as one desires to plant in checked hills or simply in drills. In this manner possibily one man can drop and cover two acres per day.

With a hand corn planter or "corn jabber" each man can plant 4 or 5 acres a day. With a single row, one horse planter, 8 or 9 acres may be easily covered while with a two row planter, 15 or 16 acres is a fair day's work. However, if the hills are "checked" with the latter machine slightly less can be accomplished. The checking device consists of a wire chain 90 rods long which has a sort of knot at regular intervals of 40"-44" throughout its length. The chain is staked at each end of the rows and as the team goes along the chain slides through the planter each "knot" opening the planting device. If the ground surface is level, and if the chain is so placed that the first hill of each row comes in line with the first hill of the preceding rows,—then when planted the field will be well "checked" and the corn may be cultivated in either direction. The chain must be reset after each trip across the field. Ordinary grain drills may be used in planting corn, using every fourth, fifth or sixth hoe only, stopping the others with pieces of cardboard or tin over the various openings in the seed box. The amount of seed used will be excessive, especially if kernels are small. Thinning the stand will be necessary. Sprockets for planting corn and beans in hills usually are sold with ordinary grain drills now. With these less thinning becomes necessary. Grain drills are much heavier than corn planters and require more power.

Listing corn is a practice common in the arid and semi-arid sections of the states. The ground may have been previously prepared by plowing or by listing but often such work is not done. The lister is a double moldboard plow like a "middle-burster." To this is attached a planting device similar to that upon ordinary planters. The corn is planted in the furrow immediately behind the plow. The soil here is moist but sometimes rather cold. Subsequent cultivation fills the furrow so that when corn is laid by the surface is fairly level. Listing is a substitue for plowing in which only about ½ (or less) of the land is really turned. If double listed the work more nearly corresponds to plowing. The advantages are that plowing and planting are done at one operation and the corn is in furrows protected from the wind while very small, and getting full advantage of all moisture. With heavy rains occurring while corn is small—especially upon heavy soils, the crop would be drowned out and would have to be replanted.

A special type of cultivator—called a lister cultivator—is necessary to work listed corn while it is small. With three horses, 7½ to 8 acres a day may be listed and with a double row lister, 15 to 16 acres should be planted in ten hours. Experiments to compare listing with surface planting result sometimes in favor of one method—and sometimes in favor of the other. The depth at which to plant is determined by the nature of the soil and the moisture content. Corn may be planted deeper in loose dry soil. The distances at which to plant must be determined by actual experience extending over several years. The fertility of the soil, its moisture holding capacity, the rainfall and the variety grown are factors which largely determine the optimum number of stalks per acre.

Hunt in his "Cereals in America" says 21,780 stalks in Connecticut, and 2,184 stalks per acre in Georgia are cited as having given best results. In Ohio about 12,000 per acre are usually planted, which is equivalent to three stalks per hill planted 3'x3'6"; or1'x3'6" in the drill, which is the rate over a considerable portion of the corn belt. In the South where soils are thin and hot dry summers prevail—single stalks 6x2 or 4x3 are usually planted, or 3630 stalks per acre. When the rows are placed 4½ to 6 feet apart, cowpeas in single or double rows are always interplanted.

CULTIVATION OF CORN.

The objects of cultivation are to conserve moisture and to prevent growth of weeds. The latter take up moisture and available plant food which should go to nourish the crop. Experiments show that no crop will be obtained where weeds are allowed to grow undisturbed. The preservation of a soil mulch to conserve moisture is more or less important where rain fall is deficient. In recent experiments, as good returns have been obtained by hoeing off weeds as by cultivating which proves that deep cultivation is unnecessary. Hoeing is expensive and the hard surface resulting does not readily allow percolation of falling water—so that cultivation is preferable. Deep cultivation seriously injures older corn and is unnecessary on young corn unless the preparation of soil before planting was poorly done. Ordinarily the first cultivation of corn is made with a light smoothing harrow. This is a cheap means of destroying weeds as they first start to grow and the corn being more firmly rooted is not injured. The next cultivation must be very thoroughly done with small shovels next to the rows—or with fenders used to prevent the covering of the corn but allowing enough dirt to be moved to cover the weeds in the row. If this is done at the proper time no hoeing will be necessary even for corn in drills. If wet weather prevents, the weeds get the start and are much harder to eradicate, in which case the corn in checks is more easily cleaned since it can be cultivated in two directions.

The two following cultivations throw a little dirt to the row and clean the middles—at the same time preserving the soil mulch. In case weeds get beyond control, a disc cultivator which will throw considerable dirt to the row may be the means of saving the crop. Ordinarily however it is best not to ridge the corn, since in a ridged surface more evaporation takes place. Where rains are too plentiful, however, ridging protects the corn. It is a common idea that ridging is necessary in places exposed to the wind, but such is not always the case. Where the wind has been continuous, where the growth has been medium rather than rapid, and where the ears are borne low, the corn is not easily blown down.

THE MOISTURE REQUIREMENTS OF CORN.

Prof. King, of Wisconsin, found that to produce 1 ton of dry matter in corn 270 tons of water were required, an equivalent of 2.4 acre inches. Hunt states that at the Illinois Station from 18 different varieties upon 18 tenth-acre plats, with a rainfall during the growing season of 13"—32 bushels of dry shelled grain was obtained per acre; while in the following year with same varieties upon the same plots, similarly tilled, but with 22½" rainfall, the yield was 94 bushels per acre. This shows a gain of 6.5 bushels for each inch of rainfall above 13". The distribution of rainfall is as important as the amount. From the time that the ears begin to develop any lack of moisture will be shown in the yield, and a full crop is assured only when corn receives a plentiful supply of moisture during this stage of its growth. Where it is known that rainfall at such time is not to be depended upon, conservation of moisture by clean shallow cultivation must be practiced. In some sections earlier maturing varieties may prove advantageous over later ones now grown, since the ears will be filling out at an earlier date, before the effect of lack of rain is felt.

FERTILIZING REQUIREMENTS.

Profitable crops of corn have been grown in Illinois and other states of the corn belt upon the same soil for as many as 60 years. This could be done only on a fertile soil, yet nobody at this time is ignorant of the fact that such a practice results in depleting the fertility of the soil. According to tables in Henry's Feeds and Feeding a ten ton crop will remove 58 lbs. Nitrogen, 22 lbs. phosphoric-acid and 78 lbs. of potash. Where only the grain is removed, the figures would be 46, 20 and 16,—much of the potash being found in the stover. Such a drain upon the fertility for a score or more of years would ruin any but the best soils.

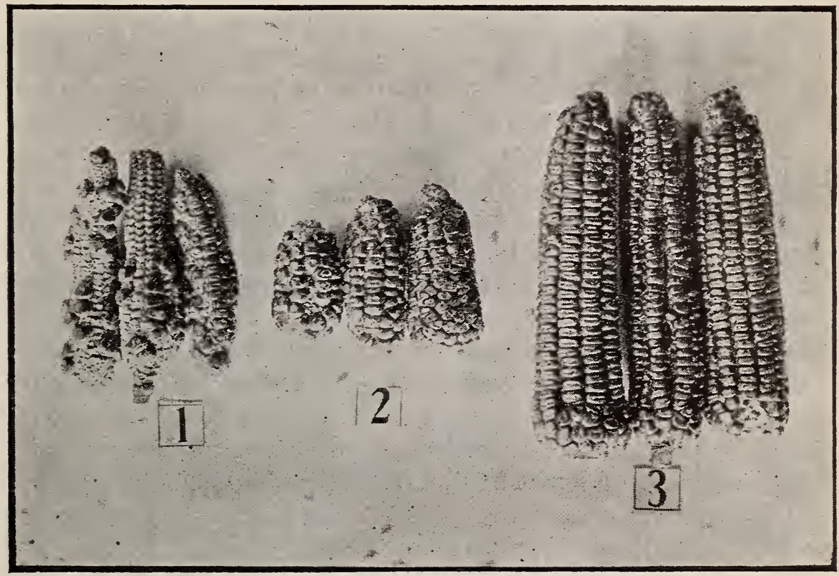

Figure 3. Effects of Fertilizer upon Corn (Kauai):
1. No fertilizer.
2. Vegetable fertilizer.
3. Barnyard manure.

Barnyard manure has been found to be the best fertilizer for corn. Organic mater in any form increases the production. Where rotations are practiced, the manure is applied to old meadows and the stubble and roots there found also help to increase the amount of organic matter. Commercial fertilizers are of value, but not to the same extent as for small grain crops. This is true also upon Hawaiian soils. Fig. 3 shows the results of manure, and of commercial fertilizer upon corn grown on Kauai. When fertilizers are applied, one analyzing 8 to 9 per cent phosphoric acid, 1 to 2 per cent. nitrogen and 2 to 4 per cent. of potash is usually recommended, in applications of 200 to 400 lbs. per acre.

ROTATIONS for corn are various because of the great variation in crops grown in different places. Rotations generally consist of corn, some one of the small grains, and hay crops, including a legume for enrichment of the soil.

In the Northeast states corn occurs in rotations with oats and with timothy mixed with clover. In the Southern states corn and cotton occur in two year rotations, cowpeas being planted in the corn. In some sections a three year rotation is practiced, winter oats followed by cowpeas being included with the corn and cotton.

In Hawaii corn may be grown as an annual crop—but in rotation with such winter crops as oats, wheat, rye, barley, either alone or mixed with some such legume as red, alsike, crimson or burr clover (1) or with cowpeas, velvet beans, vetches.

Above or near the frostline, some one of the small grains, with a hardy legume such as the clovers and vetches, could be grown and pastured off and cut for hay, or turned under for green manure.

In the central West, wheat often follows corn, being planted in the standing corn in September or October. For this purpose a small, one-horse, five disc drill costing $12.00 to $15.00 is used. Wheat makes excellent pasture during winter months and a fair yield of grain in the summer, additional. Probably rye or wheat will prove more valuable for early planting in corn, and oats or barley for late planting. Seeds of all of the legumes are very expensive and this fact, together with the uncertainty of obtaining a full stand accounts for the rare use of legumes as winter crops. Small grains, however, should be grown whereever possible to prevent leaching or blowing of the soil, and to furnish pasture and green manure. The only objection that can be given to their use is that to obtain full value for them, only spring plowing is possible and even this must be postponed until the last possible moment—thus making an excess of work to be done within a comparatively short time. Fall and winter plowing are thought to be necessary for some soils—to allow for action of frost and to permit percolation of rainwater. The growing of a winter cover crop accomplishes practically the same result in milder climates—the roots improve the physical condition of the soil, the tops induce percolation by preventing surface drainage; and the cover crop has two advantages in that it also prevents leaching of plant food during heavy rains and furnishes material for green manuring.

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(1) Clovers should be first tried out upon a small scale and their value for the given conditions determined

INTER-CROPPING.

In parts of the South, or upon some soils where, because of thinness of soil and danger of drought, more space is allowed individual plants—the intervening spaces are to some extent filled by planting cowpeas. On richer soils, where moisture is plentiful, the same practice obtains, notably in the cane sugar districts of Louisiana. The cowpeas may be scattered and covered when "laying by" the corn or they may be planted in rows between the corn with the one-horse corn planter. Soybeans, Jack beans, velvet beans, garden peas, navy beans, dwarf Lima beans or other garden or truck crop might be similarly planted for enrichment of soil, and for food purposes. As stated under the subject of rotations, small grains are likewise planted between rows of corn. In the North, prior to the days of the corn harvester, pumpkins were well esteemed as a plant to grow with corn.

DISPOSAL OF CORN STALKS.

When uncut stalks are fed as a soiling crop or as stover, there is considerable waste in the large part of the stalk uneaten—much more of course when the dry stover is fed. When the stover is shredded or the fodder cut into silage, the per cent. of waste is but very small. If fed to the cattle in pastures the waste may be distributed by feeding always in a different place. When fed in stables or feed lots the waste material must then be hauled out and scattered where wanted—usually upon the cultivated fields. When left in the field standing, the stalks are grazed, broken and trampled down by the livestock which are usually turned in to feed upon leaves and immature ears, grass, etc., in the field. The pasturing of corn stalks is attended with some danger. Epidemics of cerebro-spinal meningitis (corn-stalk disease) have occurred quite frequently in late years. Particularly, when wet, and the leaves and immature ears become moldy—and when the stock have access to no green feed, is there danger in such pasturing. Care should be taken to first turn stock into corn fields only when they have full stomachs—to prevent overfeeding upon the unaccustomed dry material.

Whether pastured or not, there is a large amount of material left upon the field, the disposition of which varies in different regions. Usually to flatten down the stalks a heavy timber 16′ to 20′ long is dragged across the field, taking several rows at once. With level smooth fields longer timbers with a team attached to each end may be used. In early morning when the ground is frozen slightly is considered the proper time for this work in the corn belt. The next step is to rake the stalks into windrows with a hay rake and burn them, after which the ground may be more easily plowed and prepared for the following crop.

Where wheat has been planted in the corn, the stalks are not burned but are left and turned under when plowing the wheat stubble.

To avoid the loss in vegetable matter caused by burning, stalk cutters are now coming into use and except where the mass of material is excessive, they so cut the stalks that the pieces are easily turned under with the plow. These implements are made in one-row and two-row styles and have several blades on a revolving head—the blades cutting the stalks against the soil, which must be rather firm, into pieces perhaps 8″ long.

THE MAINTENANCE OF THE FERTILITY OF OUR CORN LANDS.

In Hawaii where there is a limited area adapted to the production of corn the maintenance of fertility is important. As stated under the subject of fertilizers, organic matter is very valuable. The destruction of organic matter by burning should in no case be allowed. The practice is common in Kula but should be changed. All of the stalks and all manure obtainable should be turned under to form humus. Legumes should be grown to aid in replenishing the supply of nitrogen. The Cornell station has demonstrated that the legume crop fertilizes the non-legume crop, when the two are grown together, as well as storing up nitrogen for future crops. Winter cover crops to prevent leaching, washing, or blowing, and to be plowed under for green manure, are invaluable. Longer rotations, in which corn appears not more often than once in two or three years, should be tried, if the other crops can be made at all profitable.

The keeping of livestock, the feeding of the field products, and the sale of finished products rather than of raw materials, are well recognized methods of avoiding depletion of fertility. In case of the sale of products which are grown at great expense of fertility, some return should be made by purchasing or growing fertilizing materials to make up for the loss.

HARVESTING CORN.

The time of harvesting or stage of maturity depends upon the product desired. For silage, corn is cut while still green. For grain only, corn is left until some time after becoming mature. For grain and stover, corn is cut when lower leaves are drying. For more grain than stover, leaves or tops may be removed while yet green, but the stalk and ear left until later.

There are several different methods in vogue in the United States for handling the corn crop, and in some cases the work is divided, the grain and roughage being harvested separately.

In the South there is much less livestock kept than in the North, and but little of the roughage is harvested. In some sections it is the custom to go through the fields just previous to the time when the leaves begin to dry and strip them from the stalks. Small bundles of these leaves are hung to stalks to dry, after which they are stored for feeding. The leaves when saved thus make valuable feed, but the process is an uneconomical one.

Another method practiced in some sections is, when the lower leaves have dried, to go through and cut off the stalks just above the ears. These tops are tied in bundles, shocked for a time to dry, then stored for future use. This feed is less valuable than equal weights of "pulled fodder," and the amount of labor involved makes the feed expensive also.

In all sections of the South the corn is pulled from the stalks with ¾ or all of the husk left on to protect the corn from weevils. To safely store corn in the husk or "shuck" it is necessary to allow it to become thoroughly dry before harvesting. The corn is fed in the ear, the husking being done at the time of feeding. After the corn is harvested, livestock are usually turned in to get what feed they can from the standing stalks and from cowpeas which are usually planted in the corn.

In the Northern states, East of the corn belt proper, it is the practice to cut and shock the entire plant at first signs of maturity, or when frosted, but preferably a few days before frosts are to be expected. After curing for six or eight weeks the corn may be husked from the shocks or the shocks may be hauled and stored and the husking done at odd times during the early winter months. An active man can cut and shock an acre a day, except in very heavy corn. A "shocking horse" or "corn saddle" is used. The former consists of a 1½"x1½" x18′ pole, supported at one end by two diverging legs at a height of 3′ to 5′, depending upon the height of the corn. A few feet back from these supports a slender iron rod 4′ long passes through a hole in the pole. In the angles thus made the corn is shocked well bracing the stalks toward the center; the shock is tightly bound near the top, the rod is removed, and the horse is then carried forward for the next shock.

The corn saddle is made by bending the stalks from four hills, situated at the corners of a square about 3½′ on a side, toward a central point and tying one about another until a support is made against which the corn is shocked as above described. When removing such shocks however, it is first necessary to locate and sever the stalks of the support which were not cut at harvest time. Shocks made by this method retain their shape and preserve the corn usually better than those made by the first method, especially in stormy weather. The feed loses value so quickly in such weather that the aim is to get it under cover as soon as possible and the former method entails less labor both at harvest and hauling time.

From 25 to 50 shocks are made per acre depending on the amount of corn there is present and the stage of maturity and weather conditions. With drying weather and corn nearly mature larger shocks may safely be made, while otherwise small shocks should be made. Where the corn is to be fed to fattening cattle the entire plant may be fed without any husking.

The stover, whether the husking has been done in the field or in the barn is fed out to livestock during the winter, most of the uneaten portion being returned to the land with the manure. Within recent years the above method has been modified by the use of huskers and shredders. These are power machines which remove the ear from the stalk and husk it, and shred the stalks and leaves, delivering corn into a wagon and stover into barn or stack. In this way much hand labor is avoided, the work of husking is not drawn out for several weeks, and the resulting feed is more completely consumed.

Shredded stover, unspoiled, makes excellent feed, provided the corn was not damaged by too long exposure in the shocks. When shredded, the stover is easily spoiled by molding unless perfectly dry at time of shredding. The writer recalls that three methods were used to avoid loss by molding:—(a) if possible to shred at intervals of a few weeks so as not to have the shredded stover in too large piles; (b) to mix oat or wheat straw with alternate layers of the stover; (c) to shred only in cold weather and when stover was perfectly dry.

In this same region also it must be remembered that the silo is in common use for preserving a part of the corn crop. For cutting the corn for silage and to some extent also for cutting it for the shock, the corn harvester is now in use, but the cost of cutting has been reduced only slightly. For silage late maturing Southern varieties have been used but the silage therefrom was very "sappy"; ordinary late varieties, if cut at the proper time, make about the same amount of dry matter per acre.

In the corn belt proper, the acreage in corn is so large that the harvesting of the entire crop would produce an unnecessary amount of feed and the work of saving it would have been almost impossible in many cases. Some corn is placed in silos, some is shocked and possibly shredded, but over by far the larger area, the corn is husked from the standing crop, after which livestock are turned in to pick up what they can. For this work the wagon is fitted with an ordinary double wagon box (holding about 50 bu. of wheat) along one side of which boards or a woven screen on a frame is erected, making the side about four feet higher than the opposite one. The corn is thrown against this "throwboard" or "bump board" by the husker (who seldom glances at it) and falls back into the box. The wagon box is also fitted with a hinged rear end-gate, in place of the regular one, known as a "shoveling board" or corn end-gate. This can be dropped to a horizontal position and shoveling commenced at once without any hand work, when the crib is reached. The capacity of these boxes is figured as one bushel for every inch in height, plus four for the shoveling board which lengthens the box a few inches. A 36″ box would hold 40 bu. A steady team that will follow the row and start and stop when told is necessary. After a few days at the work, the team usually walks along slowly, nibbling at the corn stalks, and pulls the wagon about as fast as the operator can husk his two rows, without command from him. Ordinary husking pegs of wood or metal are used in the hand but for rapid work a hook held by a strap near the base of the thumb is used. With this, experienced men rip off the husk, snap the ear, and throw it in the wagon at a single motion. Such men, in good corn, husk from 75 to 90 bus. per day, while from shock corn, 35 to 40 bus. is considered a good days work. Corn must be well dried before husking if large amounts are to be stored in one crib.

THE CORN SHOCKER is similar to the corn harvester in some respects, but at the rear of the machine is a platform upon which the fodder is shocked. When the shock is completed the team is stopped, the shock raised by tackle and set upon the ground at one side, after which the machine is again started. This machine is not in very common use although successful in operation.

THE CORN PICKER, an implement for picking the ears from standing corn, is not as successful as the preceding and is rarely found.

THE SLED CUTTERS. Besides the machetes, or cane knives, and the corn binders in use for cutting corn, sled cutters are sometimes used. The essential principal of this is a strong cutting knife held horizontally but at an angle of 45° to the row of corn to be cut. As the knife is pulled forward, upon sled or wagon ,the blade makes a "draw-cut" severing the stalks of corn. Some sleds are equipped with two such knives, so that two rows may be cut. Some, again, have seats for two men who catch the stalks as cut and drop them off in bundles. For cutting for silage, the writer once worked upon a low "handy" wagon equipped with such a blade; one man stood behind it and threw the stalks, by armfuls, upon the platform of the wagon, while another, or perhaps two, aided in arranging the load.

STORING THE GRAIN.

As mentioned above the corn is, in some regions, stored with the husk left on, and in others, free from the husk. The protection from weevils, which the husk gives, may be attained by drying the corn in a kiln after the manner of drying hops. When thus dried the outer hull is so hard as to in large measure protect the corn.

Upon the smaller farms of both North and South, corn is stored in long, narrow cribs, having slat sides to allow for proper ventilation. Slat bottoms are sometimes built. In some cases the crib may be a part of the feed barn, a part of a general granary, or it may be a structure put up expressly for corn. Usually granaries or corn cribs are permanent structures raised from the ground 3½′ to 4′ on 8″x8″ supports, over which tin pans are inverted, or other device employed, to keep out rodents. In the corn belt proper, large permanent cribs are employed, particularly in the humid sections. Besides these, and more especially in the semi-arid sections, temporary cribs are in use. For these a closely woven wire fence, a special weave of woven wire for crib purposes, or a special weave of slat and wire fencing, is necessary. In constructing the crib, two posts 6″ or 8″ in diameter are set in the ground 4′ apart. If 4 foot fencing is used, the posts must extend 8′ above the surface when set. The posts must be well bound together at the top. One post would answer the purpose of holding the wire erect, but with two, the space between is boarded up when filling, with light boards which are easily removed and this space used as a doorway when corn is to be moved. The cribbing is made in certain lengths and the fencing may be cut to make a crib from 12′ to 25′ in diameter, as wanted. After stapling the wire to the posts, a rough floor is constructed, yet it should be sufficiently smooth to allow for use of scoop shovels when removing the corn. When filling, the wagons must not be unloaded at the same place each time, but at different places, so that the crib will retain its upright position. When filled to the height of the wire, another section is placed directly above and wired to the lower one. Then when filled heaping full, rounded towards the center, a canvas may or may not be thrown over the corn for protection. Unless to be shelled soon some sort of roofing is necessary.

SHELLING THE CORN.

Upon small farms hand corn shellers are in use and also much of the corn is shelled at the mills where it is ground into meal. Individual farmers cannot afford the sheller and power, so the miller is equipped for the work. In the corn belt, large corn shellers with a capacity of 1500 to 2500 bushels, or more, per day, operated by steam power, go from farm to farm, much as the steam threshers do in the wheat belt; in fact in many localities the shellers are owned by threshermen. (Silage cutters are owned and operated in a like manner in other sections.) After shelling, the corn may be held for feeding purposes in bags or bins, or stored in grain elevators, as with small grains. When stored in bulk, moving from one bin to another is sometimes necessary if the corn is found to heat.

SHRINKAGE AND LOSS.

In silage, in the best silos, there is a loss of from 5 per cent. to 10 per cent. in total dry matter due to the carbon dioxid evolved. If kept for some months the loss will be still greater. In field curing, an average of about 20 per cent is lost. The loss in each case is in carbohydrates other than fiber.

There is a reduction in yield of grain amounting to 2 or 3 bushels per acre ,where attempt is made to save leaves, tops, or stover for roughage. The shrinkage of ear corn in the crib varies from about 5 per cent. to 25 per cent., with 15 per cent. as an average for average conditions. After shelling, the corn may still shrink somewhat, but most of the shriinkage occurs in the cob, which from being 1-4 of the weight is reduced to about 1-5, and loses 10 per cent. in length and circumference.

WEIGHT.

56 lbs. is the commonly accepted weight for shelled corn; 70 lbs. for corn in the cob after curing; and 70 to 80 lbs. for green corn.

YIELDS.

The following factors are the chief ones in determining the yield of corn:

1. *The fertility of the soil,* which in turn depends upon the depth of soil, the amount of humus, the physical condition of soil, whether the conditions therein are suitable or not for bacterial action.
2. *The moisture conditions,* as influenced by the water content of the soil, its water holding capacity, the amount and distribution of rainfall (or of irrigation or of sub-irrigation) and the amount of loss by evaporation or by weeds, (the number and thoroughness of cultivations.)
3. *The kind or species of corn and the variety,* its adaptability to present conditions or environment.
4. *Climatic influence;* the length of the growing season, the average, maximum and minimum temperatures, the day and night variations, and rainfall (2).

5. *The thickness of the stand,* the optimum number of stalks per acre for the given conditions and variety. A poor stand is very often the cause of reduced yields. Whether it be caused by insects, by poor seed or by too thin planting, the cost of caring for the resulting crop until harvest is the same as if the stand were perfect, therefore every effort should be made to keep down cost of production by having only good stands. Too many stalks per acre likewise results in reduced yields, i. e. of grain; the number of pounds of dry matter per acre might be increased.

The Yearbook of the Department of Agriculture gives the average yield per acre of the United States for 1911 as 23.9 bushels, the highest average yields being in the North Atlantic states (42.4 bus.) Texas and Oklahoma had 9.5 and 6:5 respectively. (In these latter states the soil is fertile enough but the rainfall is deficient). Connecticut leads the list with 48.5 bushels. Average yields, however, give one no idea whatever of what ordinary, possible, or maximum yields might be.

In the contest conducted by the American Agriculturist in 1889, a man in South Carolina produced 255 bushels of ear corn upon an acre. Incidentally, 1000 bushels of manure, 600 bushels of cottonseed, and 3600 lbs. of guano, cottonseed meal, kainit, acid phosphate, bone, and nitrate of soda were applied to the acre at different times.

Less than 30 bushels must be considered poor yield on good soils; 40 to 60 bushels are good yields, while 60 to 100 bushels are extra good yields.

In estimating green forage, a crop that will make 60 bushels of grain is calculated to make 12 tons of green feed per acre, a ratio of 5 to 1. This factor, while generally accepted in the corn states, doubtless varies. According to a test of a trial row made by the writer, the factor was 6 1-6 bu. to a ton of green feed. With this factor a 60 bu. soil will yield 9.73 tons of green feed.

FEEDING CORN.

1. As a soiling crop. In the Northern states in many places the summers are dry and hot and consequently the blue-grass pastures are usually cropped rather short and the grass ceases to grow until the fall rains come. Under such conditions or where, for any other cause, a shortage of feed in summer re-

sults, it is quite a common practice for farmers to cut daily some of their corn and feed it to the stock to supplement the pastures. Particularly is this done for dairy cattle. If it were not done, the flow of milk would be reduced and could not in the fall be increased to the proper amount.

Some dairymen, near cities where land is very valuable, make a practice of soiling their cattle at all seasons, since in cultivated crops much less acreage is required than in pasture.

2. As silage. (See Press Bulletin No. 40). The feeding of silage is becoming more common as time goes on, and the value of silos and silage better appreciated. Silage is a succulent feed, available when other such feeds are wanting, and hence of great value. In experiments with milk cows, silage produced from 5 to 11 per cent. more milk than an equal weight of fodder, cut and allowed to dry in the ordinary manner. In is only with fat steers on full feed that the superiority of silage is questioned. In the corn states it has been valued especially as a winter feed, but is being used more and more also as a summer feed. In Hawaii silage would be valuable indeed to cattlemen during long periods of drouth.

3. As stover. Reference has been made to the use of leaves and tops in certain sections, and to stover, whole, or shredded, as used in various regions. That the stover is of considerable value as a feed may be seen by noting its composition given on page 1. Much more livestock may be kept, and better farming done, where the whole feeding value of the plant is realized.

4. As fodder. That is with the ear still on the stalk. This is done in some sections where labor is scarce. The cattle get roughage and grain at one time and the labor of husking is avoided. In such cases hogs usually follow the cattle to prevent waste.

5. As a grain. Corn may be fed upon the ear, with or without the husks, shelled, ground with or without the cob, ground with or without other grains, soaked or even cooked.

The value of corn as a feed is so well known that no statements of it are necessary. For sheep, lambs, pigs, dairy cows, beef cattle, poultry, fattening horses, or for work animals, in fact for all classes of animals, of all ages, regardless of the purpose in feeding, corn in mixtures, or alone, acknowledges no superior. Even for man, corn as a food is important.

From the table of composition it will be seen that corn is especially rich in nitrogen free extract or in other words in non-nitrogenous constituents. For this reason some material containing larger quantities of nitrogen is usually fed with it. Clover, alfalfa, cowpeas, soy beans and peanuts are used as roughage in dry or green state.

For concentrated feed, linseed or oil meal, cottonseed meal, the seeds of cowpeas, soy beans, peanuts, etc., are used to balance up the corn in rations. More economical gains are made when balanced rations are fed. For instance, when hogs have access to alfalfa hay, the amount of corn necessary to produce a lb. of gain is reduced from 5 to 7 lbs. to about 4 lbs. With clover or cowpea hay replacing timothy a bushel of corn produced 1.65 lbs. beef more than with the timothy hay. In a similar case, the output of milk was increased 20 to 33 per cent. Other examples could be given, but these are sufficient to demonstrate the point that balanced rations are more economical. Corn is considered a very heating food and in the Northern States is fed to work horses in the colder months, oats being reserved for the summer months. when the work is more severe. However in the South oats are less profitable as a grain crop and are usually cut green for hay. Moreover the acreage in oats is very small. Corn is fed to work stock the year round with no bad results, nor with any complaints as to its being a "heating" feed. "Corn chop" is a term which in the South usually applies to coarsely ground or cracked corn. In the North, the same term applies to a finely ground mixture of corn and oats, or corn, cob, and oats. Grinding the corn increases its value as a feed for hogs and cattle, more rapid gains on less grain being usually (not always) obtained. Where hogs follow cattle but little gain is obtained by grinding, and by feeding whole grain, much labor and expense is avoided.

Corn and Cob Meal. Cobs may be ground with the corn under certain conditions and for certain kinds of stock. For hogs the cobs should not be included. For a few months after harvest, while cobs are still more or less soft, they may be used, but in late Spring months and in the following summer, few farmers feed corn and cob meal. According to Henry (Feeds & Feeding) theyserve to lighten the otherwise heavy mass of corn meal, making it more easy to digest. The actual value of cobs is very, very small.

Ground corn, whether with or without the cob, and especially when ground with oats, heats readily and cannot safely be stored in bulk. Only small amounts should be ground at any one time. After grinding, also ,the oil "soon becomes rancid and gives the meal a stale taste." Soaking the corn or corn meal is more or less practiced, and is thought to increase its feeding value, especially for hogs. In Kansas a gain of from 5 to 15 per cent. was obtained by soaking corn for steers. In Germany sheep on dry grains increased 12.1 lb. more in 14 weeks than those on wet grains, the lack of gain in the latter being attributed to a decreased secretion of saliva. No advantage was found in soaking the grain for horses.

The chief value of corn is in producing "heat, energy, and fat." Because of its deficiency in protein and ash constituents, it is not a perfect food for young growing animals, nor for breeding stock. The deficiency must be supplied in other feeds.

CORN AS FOOD FOR MAN AND ITS USE IN MANUFACTURES.

Corn meal is a valuable food for man and the annual consumption of corn as bread, cakes, or mush, is quite large. Freshly ground meal is much superior for culinary purposes.

Food products other than the meal are roasting ears, hominy, corn combined in various breakfast foods, canned corn, and corn starch. Manufactured products include glucose, starch, alcohol, whiskey and malt liquors, and corn syrup, with which is usually mixed some ribbon cane syrup to improve its flavor.

The by-products resulting include: oil, gum, dextrins, germ oil meal, gluten meal, bran, gluten feed (meal and bran), distillers' and brewers' grain, hominy feed, cerealine feed.

The pith of the stalk is used for packing and in the manufacture of explosives, the balance of the plant in this case being ground, forming a good substitute for hay, under the name of "new corn product." The composition of the by-products is given by Hunt as follows:

	Water	Ash	Protein	Crude Fiber	Nitrogen Free Extract	Fat.
Gluten meal	9.2	1.1	36.9	2.2	46.7	3.9
Maize bran	9.1	1.3	9.9	12.1	62.0	5.6
Gluten feed	8.5	1.2	25.7	6.7	53.5	4.4
Germ oil meal	9.1	2.6	23.0	9.0	45.6	10.7
Hominy feed	9.3	2.7	11.2	4.5	63.7	8.6
Cerealine feed	10.2	2.6	11.2	4.6	63.3	8.1
Distillers' grains	8.8	2.4	35.	12.1	30.4	11.3
New Corn Product	8.5	5.4	6.5	27.3	49.3	2.9

THE POLLINATION OF CORN.

The pollination of corn is effected by wind and by the force of gravity. The tassel is the male portion of the flower, while the female portion is borne in the axils of the leaves. The silk is the "style" of the pistillate flower and is supposed to be a long tube down which the pollen grain must pass to reach the ovule. To effect pollination the silks must be at a certain stage of development when the pollen is available. Ears having no grains at butt, or at tip, show that the silk of butt and tip respectively was immature or past mature and were consequently not pollinated. If such barrenness is noticed to be very common it can in part be corrected by planting rows here and there across the field either earlier or later, as the situation demands, to furnish pollen at the proper season or to lengthen the season in which mature pollen is available. Rarely does one see an ear entirely barren of kernels, but isolated stalks on windward sides of the field in regions of continual wind occasionally produce such ears. Short ears result from poor conditions of environment, not from imperfect pollination. Barrenness also is largely the result of environment—too thick a stand, weeds, poor soil, or lack of moisture.

Suckers very often produce hermaphrodite or perfect flowers. Tassel ears also result from perfect flowers in the tassel. Such ears, or the tendency to form such ears, is undesirable. Avoid these plants when selecting seed.

CORN IMPROVEMENT.

Some of the greatest strides in recent agricultural science have been made in the various states in the work in corn improvement. The work is divided into two branches, viz: seed selection and breeding.

SEED SELECTION is based upon the law that "like produces like," and if good corn is to be expected good corn must be planted. Following this idea, intelligent farmers have selected their seed corn for many years. Now, however, it is known that excellence in plants may be due either to heredity or to environment, and seed selection becomes more complicated in that an effort must be made to secure the corn whose excellence is due to heredity. That which is due to good conditions of environment, cannot be continued unless the same good conditions are always present. To accomplish the desired result, it becomes necessary to select seed corn from the field where one can know what the environment has been. For illustration, we will suppose two hills of corn, one containing one stalk and the other two, both of which produce one good ear. In the hill which has two stalks, the one producing the ear possesses excellence over the barren stalk due to heredity—or otherwise we should find the ear upon the other stalk or one small ear upon each. The ear from this stalk also would be superior as seed to that from the other hill which contained but one stalk, since in the "struggle for existence" a great handicap was overcome in producing it. Such conditions as plenty of space in which to grow, advantage in fertility of soil, or in excess of water, or in freedom from weeds result in producing good ears whose excellence may not be continued when again planted.

Selection in the field then enables one to see under what conditions the ear was produced and to note also the character of the stalk and leaves of the mother plant, size and weight of ear, maturity, color ,also broken plants or tendency to sucker, and the height of the ear upon the stalk. High ears tend to pull stalk down and the selection of such tends to produce a late maturing strain. For windy places select seed from short, thick stalks, with ear rather low.

The Ohio Experiment Station (in Bulletin 212) reports upon seed selection as follows:

A gain of 4 to 5 bushels per acre when seed was taken from long ears over that from short ears; one bushel, when cylindrical ears were used as compared with tapering ears; the same gain when ears filled to the tip were compared with those having bare tips; 2 to 3 bushels, when smooth kernels were compared with rough; and 4 to 5 bushels gain with heavy ears over light.

This gives an indication then of some points to observe in making selections. Weakness of stalk, as indicated by broken plants, and suckering (in part only) are heredity traits and seed from such plants should be avoided. Prof. Krauss, of the College of Hawaii, found in an ear-row test with one variety, a great variation in the tendency to sucker.

The work of selecting in the field may be done by some one well qualified for the work before the regular harvest is commenced, or, with intelligent laborers, or where the farmer himself does part or all of his work, the same result is accomplished at harvest time by having a box hung on the rear end of the wagon in which choice ears may be thrown when found.

Usually two or three times as many ears are taken as would be necessary and later a more careful selection is made from among these. The germination test also may eliminate some ears and so plenty should be taken out at harvest. In the corn states it has frequently happened that the seed of some seasons was very low in vitality and those who had seed saved from the preceding year were fortunate.

The second step is the proving out of the seed selected. Although each of the ears selected are excellent and this excellence is hereditary, yet each one has inherited a different producing power and each must be planted by itself in order to determine which are the better producers. This test is known as the "ear-to-row" or simply "ear-row" test. Upon the windward side of the field plant about 100 feet of row from each of 25, 50 or 100 ears, and duplicate the test if possible. Duplication of the test and the planting of every fifth or sixth row to corn of known producing power as a check, are methods in vogue to determine variation due to different conditions of environment. Have such conditions as uniform as is possible.

The balance of the selected ears are used in planting the main field. For the second year, the seed is selected from the high yielding corn as determined in the ear row test—while many choice ears are taken from the main crop and planted in another ear row test to compare them with the high yielding ears of the

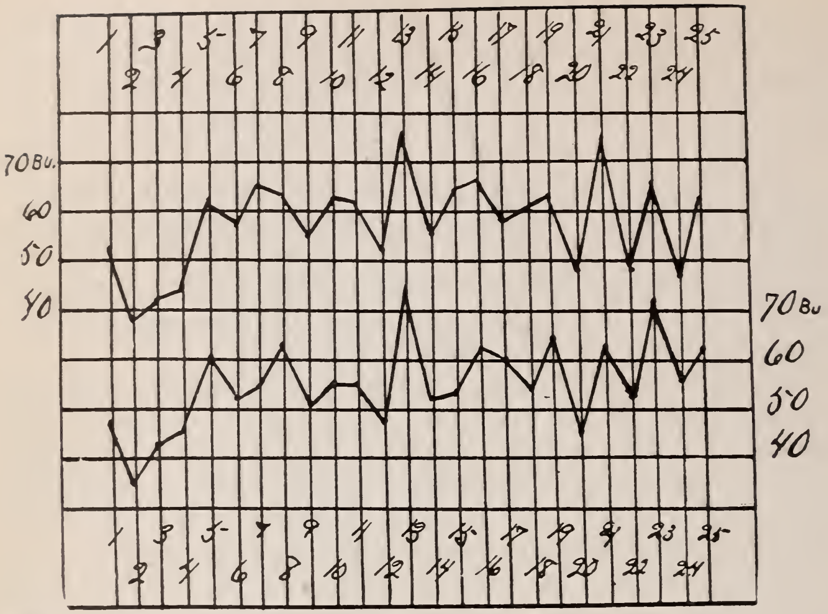

Figure 4: from Ohio Station Cir. No. 66.

The result of duplicate ear row test made by F. C. Snyder of Ohio. Thirty-five to seventy-five bushels per acre.

This test was made in 1904, the remnants were placed in the breeding plot in 1905 and in 1906 the yield from the improved seed exceeded that from ordinary seed by 7.17 bu. per acre.

How else could the excellence of ear No. 13 over ear No. 2 be determined?

previous test. It is not to be expected that all of the high yielding ears are obtained in the 100 that were first selected out of the hundreds, thousands, or perhaps millions of the whole crop—or even that the very highest yielding ones were obtained, and therefore year by year search for these latter should be made by selecting always some from the main crop for test. Seed for the main crop however should always be taken from corn that has been tested and found to be good in yield.

For large areas where the ear row test would furnish an insufficient amount of seed—some seed from the general crop could be used, but a separate plot for producing seed would be preferable. Right here the line between selection and breeding is not closely drawn. As corn is readily cross pollinated, cross breeding occurs in the ear row test, so that while the aim was only to test the different ears the resulting progeny may be better or worse than the parents according to the nature of the cross-breeding which has occurred.

BREEDING.

Under this heading then we shall consider the more complex methods which involve the use of breeding and multiplying plots. For breeding work the primary selection and the ear row test are made as above described, with the exception that portions from each ear are reserved, properly labeled, until the result of the test is known. The breeding work proper starts with the remnants of ears found to be high yielding; the other remnants are discarded.

The following scheme from Ohio E. S. Circular 66 shows the plan to be followed:

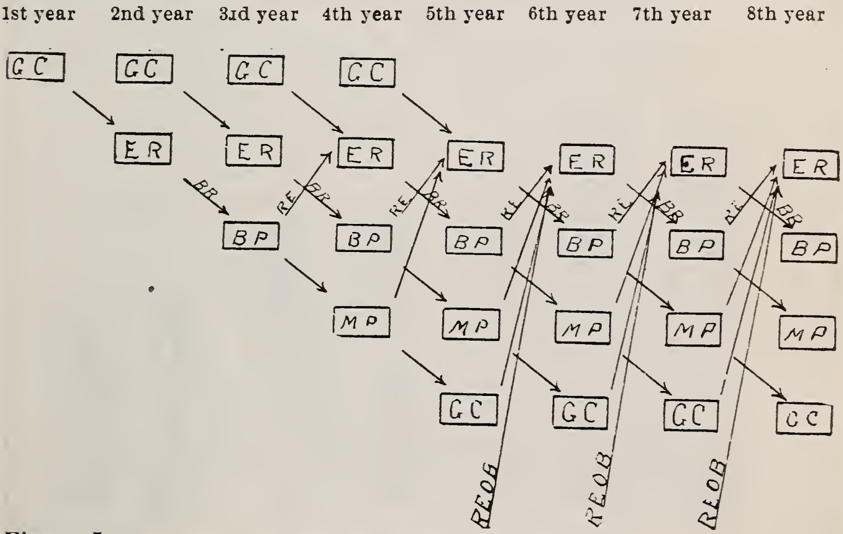

Figure 5:
A scheme for breeding corn—from Ohio Station Cir. 66. GC—general crop. BR—remnants of best ears. ER—ear row test. RE—registered ears. BP—breeding plots of remants. MP—multiplying plot. REOB—registered ears from other breeders. The arrows show the source of seed for each plot or field.

The ear row test may be placed in the main field but the breeding plot and multiplying plot must be isolated to prevent cross pollination with pollen from undesirable plants.

In the breeding plot, natural methods may be allowed or certain rows may be detasseled and the seed taken from the cross bred product of these rows. Cross breeding increases vigor, and (also to prevent inbreeding) outside blood may be introduced, after being tested in the ear row test, and its influence made certain by detasseling either the old or the new stock as stated. Outside blood is secured in selected ears, or pedigreed ears, from neighbors or others, breeding the same variety. The scheme shows how, after only four years work, the main crop can be grown from selected, improved, seed. Some such scheme as this is necessary if there is to be any improvement made in the yield of corn. The use of isolated breeding plots eliminates the bad results obtained by cross pollination from low yielding or barren stalks. These qualities are, for the most part, hereditary and cannot be entirely overcome by good conditions of environment.

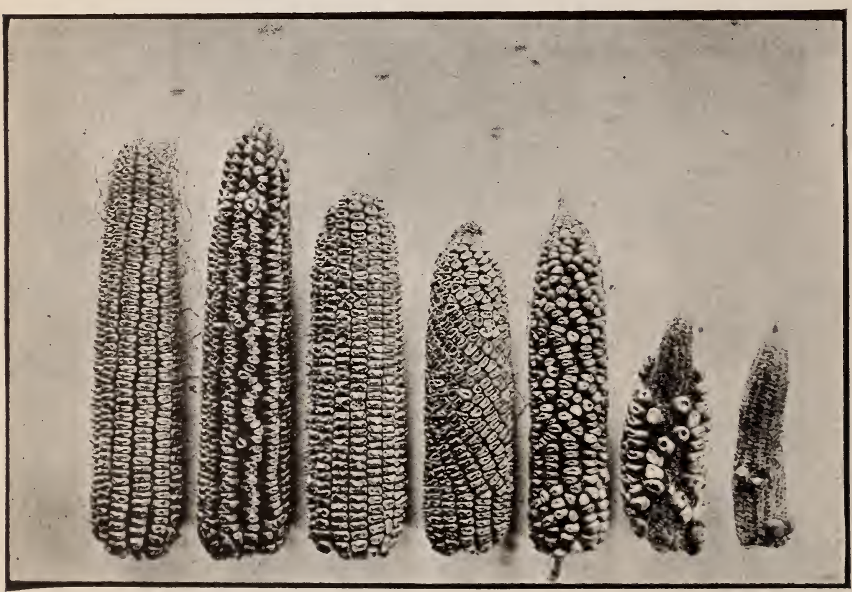

Figure 6. Types OF EARS.
1. Tapering—with wedge-shaped kernels.
2. Tapering—with oval kernels and too much space between rows.
3. Cylinrical—well filled at butt and tip—the "show" type.
4. Shows spiral rows.
5. Shows broken rows.
6 and 7. Show imperfect pollination.

Breeding, as applied to corn, means simply control of parentage, much as is the case in the breeding of animals. Hand pollination is rarely done.

IMPROVEMENT IN QUALITY.

In the above discussion of improvement, increase in yield only was considered. To increase the content of protein, starch, or oil, a similar method would be followed, selecting for seed in each instance those kernels which show the desired characters, as explained on page 2.

JUDGING CORN.

At the corn shows now being held in the various states and at the National Corn Exposition, corn is judged entirely by the ears—stalk and leaves not being considered. Usually ten ears constitute an exhibit and they are judged according to the following points:

1. The shape of the ear. This should be cylindrical or but slightly tapering.
2. Color of cob—a red cob for yellow corn and either white or red for white corn.
3. Tips. The tips should be well covered, the rows unbroken to the end.
4. Butts—well rounded, the shank 1-3 the diameter of the ear.
5. Kernels—deep, wedgeshaped, leaving no spaces between the rows. They must be firm on the cob and well filled.
6. Length and circumference of ear—the length varies in different varieties, but averages 9″; the circumference should be about 3-4 the length.
7. Uniformity—in shape and size of ears. In shape, size and color of kernels.
8. Condition—of ripeness, freedom from disease or injury, dry, firm.
9. The per cent of grain to ear—should be about 87 to 88. This point is not always considered.

Figure 6 shows ears of various shapes; rows of kernels straight, curved, or mixed; and ears well or poorly filled at the butt and tip.

Various sizes and shapes of kernels are illustrated in Figure 7.

INSECTS AND DISEASES.

(See Bul. Haw. Exp. Sta. No. 27)

The more common insect pests of the corn plant in Hawaii are the army worms and cut worms, which destroy the crop usually while young, and aphides and leaf hoppers, sucking insects which when found in large numbers soon destroy the crop at any stage of its growth.

The worms are best controlled by using poisoned bait (white arsenic 1 lb; bran 30lbs.; molasses 1 qt.; water to moisten.) Fullaway recommends also plowing a furrow about the field with steep side toward the corn, up which they cannot easily climb. Because mold board plows do not clean well they fail sometimes to leave a vertical "landside" cut, and disc plows never do. However in case of attack, the poisoned bait if placed in such a furrow would be more effective than if thinly scattered.

Aphides are at times well held under control by ladybird beetles, and are quite easily killed by various sprays—proprietary tobacco mixtures being especially recommended.

The leaf hoppers are to some extent checked by egg parasites, but not enough so. Tobacco mixtures—a decoction or as powder may be employed against them. Being well protected beneath the leaf-sheath, however, the result is not entirely satisfactory.

At the Experiment Station the leaf hopper usually destroys all corn after or about the middle of April.

Other insects doing damage at times are the wire worms, attacking the roots; caterpillars eating the leaves; ear worms, infesting the ears; and moths and weevils attacking the mature or stored grain.

If the caterpillars become numerous spray the corn with some compound of arsenic. Fumigation with carbon bisulphide is the best method for controlling insects which attack the stored grain.

DISEASES.

The most common disease of corn is corn smut. It is found in all fields, but usually only one per cent., more or less, of the stalks are attacked. The history of the disease is as follows:

The spores germinate and produce a mold-like growth which bears minute colorless spores. These latter are carried about by the wind and lodge on the corn plant. If they find a moist place, growth is at once started, and the well known black smut soon forms. The history may be completed in three weeks after which it is repeated. The repetition of the process goes on so quickly that the infection spreads rapidly about the field. Much more corn appears to be infected in the later stages of growth. Any fungi remaining undestroyed usually carry the infection over to the following year.

The only practical method of treatment is to gather the smut bodies before they open and discharge their spores—and burn them or dip them in hot water. If this be done a few times at intervals throughout the season the fungus will be kept very well under control.

From the very nature of the fungus it will be readily seen that seed treatment is of no avail. Spraying the plants to prevent growth of the spores could be done, but is impracticable.

Smut is not poisonous to animal life and can be fed with impunity, its feeding value being slightly higher than that of corn. The spores are destroyed when the fungus is eaten.

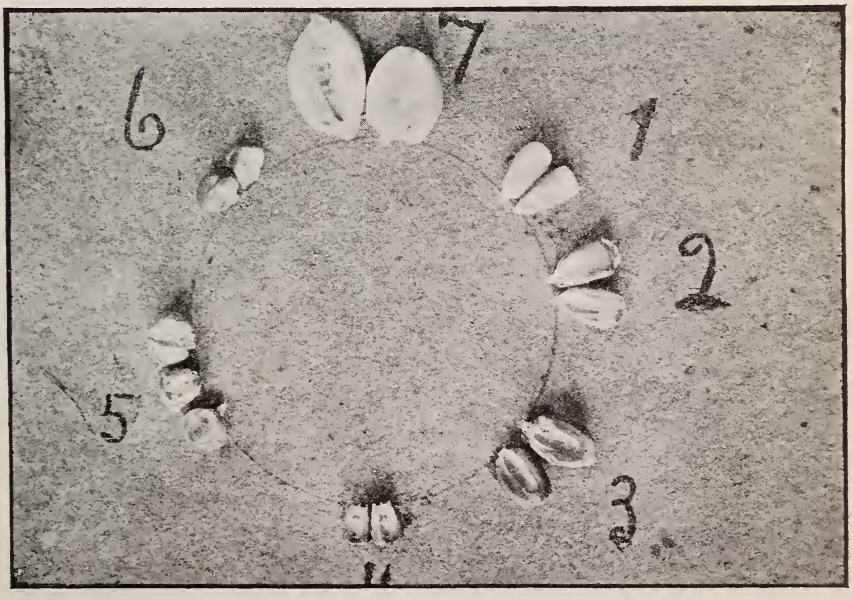

Figure 7. Types of Kernels:

1. Dent corn—long narrow wedge.
2. Dent corn—broad wedge.
3. Dent corn—oval.
4. Dent corn—very short wedge.
5. Sweet corn.
6. Flint corn.
7. Soft corn.

CORN IN HAWAII.

IN KULA, MAUI, corn is usually planted in rows about 5′ apart with hills of three stalks 4′ to 5′ apart in the rows, making about 5800 stalks per acre. Corn here is usually cultivated twice and the yield is from ½ to 1½ "tons" per acre, equivalent to 14 to 43 bushels per acre, depending upon the season. It has been a common practice in Kula to burn all husks and stalks, in preparing the land for the next crop, but in some cases the husks are now being plowed under and, on one or two farms only, stalk cutters are being used. The rainfall in Kula is obtained largely from "Kona" winds the N. E. trades being effectively cut off by the summit of Haleakala. Most of the precipitation therefore occurs in the winter months. The soil is loose and powdery and fall plowing is not necessary to facilitate the percolation of water. Corn is grown year after year and in order to maintain the fertility of the soil some green manure crops should be grown. As suggested in another connection ,small grains, especially wheat, would be found valuable for this purpose, provided of course that there is moisture enough to germinate the seed in the fall when it is sown. In the late winter the soil blows badly and a cover crop, extending over much of the corn belt would in a measure protect the region from the unpleasant dust storms now prevalent. Various legumes should be tried out for a like purpose. As stated also, plowing under of the cover crop must be postponed until the last possible moment which "congests" the spring work.

The variety of corn grown is a yellow dent, which has been more or less mixed with white varieties. As this corn has been grown for many years in this region it will probably be found to be the very best variety for the given conditions. However every effort possible should be made to improve the variety through the use of ear-row tests and breeding plats as explained on page 29.

UPON PARKER RANCH, HAWAII, corn has for some time been one of the principal crops produced. Nearly 2,000 acres are now grown annually. Some is planted near Waimea (2700-4000′) but the larger area is above the frost line at Waikii (4500-5300′). The corn is planted in rows 42″ to 44″ apart. with three kernels in hill and hills 42″ apart, making over 10,000 plants per acre. Frequent shallow cultivations are given to conserve moisture. The soil at Waikii contains, of volatile matter 25.83 per cent, of coarse sand and gravel 1.64 per cent, of fine sand 38.3 per cent, of silt 16.22 per cent, of fine silt 19.99, and of clay 2.05 per cent. It will be noticed that this is a silt loam soil well adapted to corn; the percentage of humus (in the volatile matter) is large, there is an absence of large particles of sand and also of cementing material (clay). The soil then has a great retentive power for moitsure but when dry is very floury and "blows" easily. This soil is rich in lime, magnesia, nitrogen, potash and phosphoric acid. The rainfall here is below 20″ usually, much of which falls during the cooler months. The precipitation in 1912, from April 17th to November 12th was 4.35″ most of which fell in light showers measuring .6″, .5″, to .2″, practically all of which would be valueless for the corn crop, since there was no percolation and all was lost by evaporation. An average yield of 35 bushels per acre was obtained, produced by moisture existing in the soil at planting time and which was conserved by surface cultivation. A small yellow dent corn, early maturing, and quite drought resistant is grown here. At lower elevations a larger growing variety of white dent is grown.

Upon Molokai Ranch, corn is planted at 800′ elevation in rows about 52″ apart. Heretofore single stalks 18″ to 20″ apart have been left but the plan is now to extend this interval to 30″, making 4,328 stalks per acre. Under the extremely dry conditions which prevail upon Molokai, a much smaller yield of corn than at Waikii is possible.

Upon Oahu a considerable area was for several years planted in corn at Kunia, with varying degrees of success. One year a crop of over 40 bushels per acre was obtained, while in other years the yield was reduced by attack of caterpillars and leaf-hoppers. Near Honolulu, the Experiment Station has the same varied success; winter crops succeed best, spring crops do well for a time but eventually fail. In Nuuanu valley a mall plat of corn yielded in March, 1913, 37 bushels per acre, the best row giving a rate of 60 bus. per acre. The yield of green forage was at the rate of about 9 tons per acre.

Upon Kauai no extensive areas have been tried in corn. At Homestead, judging from the results illustrated in Figure 3 it is possible to produce corn if care is first taken to manure the land. Doubtless the effect of the manure was as great through the improvement in moisture conditions as in any other way.

CONCLUSION. Corn can be grown, profitably, upon certain areas and under certain conditions, in Hawaii. It is a valuable forage plant, its worth being too well known to need explanation. It is to be one of the mainstays of the stock industry during times of drought, particularly in the form of silage. Seed from island grown corn is to be preferred, but should be carefully selected and improved by breeding. Corn thrives in Hawaii at medium elevations and upon silt loam soils. The corn crop merits more attention than it has in the past received.

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